

WHAT IS CLAIMED IS:

1. A method of roasting a food product comprising the steps of establishing the degree to which the product must be roasted to attain a desired aroma; generating a measurable first parameter which is indicative that the product has been sufficiently roasted to yield the desired aroma; storing the first parameter; roasting fresh product at a roasting temperature; monitoring a second parameter which is compatible with the first parameter and is generated by the fresh product during roasting; and, upon detecting a match between the first and second parameters, discontinuing the roasting step.

2. A method according to claim 1 wherein the first parameter is one of the color and darkness of the product and the second parameter is one of the color and darkness of the fresh product during the roasting step.

3. A method according to claim 2 including adjusting the step of discontinuing the roasting of the fresh product as a function of at least one of the roasting temperature and atmospheric pressure.

4. A method according to claim 1 wherein the step of monitoring comprises making a spectral analysis of the fresh product during the roasting step.

5. A method according to claim 4 wherein the step of making a spectral analysis comprises directing a laser beam onto the fresh product during the roasting step.

6. A method according to claim 5 wherein the laser beam has a wavelength in the range of between about 600 to 800 nm.

7. A method according to claim 1 including the steps of providing a multiplicity of different product types, establishing and storing the first parameter for each product

Sub P 2 type, prior to the roasting step selecting one of the
 5 multiplicity of product types for roasting; and wherein the
 6 step of discontinuing is carried out when a match between the
 7 first parameter for the selected product type and the second
 8 parameter match.

1 8. A method according to claim 7 including the
 2 step of establishing a plurality of first parameters for at
 3 least one of the multiplicity of product types, each of which
 4 defines a different degree to which the product must be
 5 roasted to attain correspondingly differing desired aromas;
 6 prior to the roasting step selecting one of the plurality of
 7 first parameters for the at least one product type; and
 8 wherein the step of discontinuing is performed when the second
 9 parameter matches the selected one of the first parameters.

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 2 9. A method according to claim 1 wherein the
 3 roasting step comprises flowing heated air over the fresh
 4 product, and including the steps of removing substantially all
 5 pollutants from the air downstream of the fresh product being
 6 heated, cooling the air downstream of the fresh product to
 7 substantially room temperature, and thereafter exhausting the
 cooled air into a room of a building.

1 10. A method according to claim 1 wherein the step
 2 of roasting includes flowing heated air over the fresh
 3 product, and including the steps of filtering substantially
 4 all pollutants from the heated air following the roasting
 5 step, thereafter reheating and recirculating a major portion
 6 of the substantially pollutant-free air over the fresh product
 7 to thereby continue the roasting step; and discharging a minor
 8 portion of the filtered air prior to reheating and
 9 recirculating the major portion of the air.

1 11. A method of automatically roasting coffee beans
 2 to attain a predetermined, desired coffee aroma comprising the
 3 steps of roasting a sample of the beans to a degree at which
 4 coffee made with the beans exhibits the desired aroma; sensing

one of a color and a darkness of the beans when they have reached the degree of roasting and from the sensed color or darkness generating a first parameter which is indicative of the sensed color or darkness of the bean sample; storing the first parameter; thereafter roasting fresh beans; monitoring one of the color or darkness of the fresh beans being roasted and generating a second parameter which is indicative of a color or darkness of the fresh beans; comparing the first and second parameters during roasting of the fresh beans; and terminating the roasting of the fresh beans when the first and second parameters match.

12. A method according to claim 11 wherein the step of roasting the fresh beans comprises flowing heated air over the fresh beans; and including the steps of cleaning the heated air after it has passed the fresh beans so that the air is substantially pollutant-free; cooling the air after it has passed the fresh beans to about room temperature; and discharging the pollutant-free, room temperature air.

13. A method according to claim 12 wherein the steps of roasting the fresh beans and heating, cleaning and cooling the air are performed in a substantially closed room frequented by humans, and wherein the step of discharging the air comprises discharging the air into the room.

14. Apparatus for roasting coffee beans comprising a container having a bean inlet and a bean outlet for holding beans to be roasted; an air circulation system operatively coupled with the container for flowing heated air over the beans and thereby roasting the beans, the heated air exiting the container as used air; an air cleaning arrangement operatively coupled with the air circulation system and located downstream of the container for removing substantially all particulates, smoke and volatiles entrained in the used air as it flows through the container to provide substantially pollutant-free used air; an air cooling arrangement operatively coupled with the air circulation system downstream

13 of the container for cooling the used air to about room
14 temperature; and a used air discharge located downstream of
15 the air cleaning and cooling arrangements for discharging at
16 least a portion of the used air into an indoor environment
17 substantially without adversely affecting the environment.

1 15. Apparatus according to claim 14 wherein the air
2 circulation system includes a flow divider returning a major
3 portion of the used air to the circulation system and
4 discharging a minor portion of the used air into the
5 environment.

1 16. Apparatus according to claim 15 wherein the air
2 cooling arrangement is operatively coupled with the air
3 divider so that only the minor portion of the air is cooled to
4 about room temperature.

1 17. Apparatus according to claim 16 wherein the
2 cooling arrangement is operative so that the major portion of
3 the used air which is being returned to the circulation system
4 has a temperature substantially higher than room temperature.

1 18. Apparatus according to claim 14 wherein the
2 used air discharge discharges all used air into the
3 environment.

1 19. Apparatus according to claim 14 wherein the
2 container comprises an inner drum rotatable about a generally
3 horizontal axis and an outer, stationary drum disposed about
4 the inner drum.

1 20. Apparatus according to claim 19 wherein the
2 inner drum has an open axial end and the outer drum has an end
3 plate overlying the open end of the inner drum, the end plate
4 including a bean inlet for introducing fresh beans into the
5 inner drum for subsequent roasting and an outlet for removing
6 roasted beans from the inner drum.

1 21. Apparatus according to claim 20 wherein the end
2 plate includes a window for viewing an interior of the inner
3 drum from an exterior of the outer drum, and wherein the inner
4 drum includes radially inwardly projecting vanes extending
5 generally in a longitudinal direction of the inner drum and
6 being shaped so that the vanes form intermittent streams of
7 beans being roasted and flowing past the window when the inner
8 drum is rotated and beans are disposed therein.

1 22. Apparatus according to claim 21 including a
2 reflectometer mounted proximate the window for determining a
3 darkness of the beans flowing in the intermittent stream of
4 beans past the window.

1 23. Apparatus according to claim 22 including means
2 for removing the beans from the drum through the bean outlet,
3 and a controller operatively coupled with the reflectometer
4 and the bean outlet for initiating a removal of the roasted
5 beans from the inner drum when the reflectometer senses that
6 the beans in the drum have reached a desired darkness.

1 24. Apparatus according to claim 20 including a
2 fresh bean storage hopper having a plurality of fresh bean
3 storage compartments, a conveyor for directing beans from the
4 compartments to the bean inlet, and means for transporting
5 beans from a selected one of the compartments to the conveyor.

1 25. Apparatus according to claim 24 wherein the
2 transporting means comprises an opening in each compartment
3 and an openable closure for each opening so that beans can be
4 transferred from a selected one of the compartments to the
5 conveyor by opening the closure.

1 26. Apparatus according to claim 24 wherein the
2 conveyor comprises a conduit which gravitationally transfers
3 the beans from the opening in the selected one of the
4 compartments to the bean inlet.

1 27. Apparatus according to claim 26 wherein the
2 hopper is movable relative to the bean conduit for positioning
3 the opening of each compartment relative to the conduit to
4 gravitationally flow fresh beans from the selected one of the
5 compartments to the conduit.

1 28. Apparatus according to claim 27 including a
2 scale for weighing an amount of beans to be transferred from a
3 selected one of the compartments to the conduit, wherein the
4 conduit has an intake end remote from the bean inlet, and
5 wherein the scale is positioned between the opening in the
6 selected hopper compartment and the intake end of the conduit
7 so that the amount of beans can be gravitationally fed into
8 the intake end of the conduit.

1 29. Apparatus according to claim 20 including a
2 roasted bean cooling tray arranged to receive roasted beans
3 removed from the inner drum via the bean outlet in the end
4 plate.

1 30. Apparatus according to claim 29 including a
2 wiper operatively coupled with the cooling tray for moving the
3 roasted beans over the tray and to a cooled, roasted bean
4 collector.

1 31. Apparatus according to claim 30 including means
2 for flowing a roasted bean cooling air stream past the beans
3 on the cooling tray.

1 32. Apparatus according to claim 31 wherein the air
2 circulation system includes a fresh air intake, and wherein
3 the fresh air intake is operatively coupled with the cooling
4 air stream flowing means for preheating fresh air entering the
5 air circulation system with heat obtained from the roasted
6 beans on the cooling tray.

1 33. Apparatus according to claim 32 wherein the
2 roasted beans on the tray give off white plume smoke, and

including an air filter in a vicinity of the air intake of the air circulation system for removing white plume smoke and particulates from the air flow entering the air circulation system.

34. Apparatus according to claim 33 wherein the filter comprises a stainless steel mesh filter having a mesh size sufficient for removing particles having a size larger than about a 1/2-micron size from the air entering the air circulation system.

35. Apparatus according to claim 14 wherein the air circulation system includes means for heating the air flowing therein to a roasting temperature upstream of the container.

36. Apparatus according to claim 35 wherein the heater includes a combustion-free main heater for heating the air to the roasting temperature and an auxiliary heater for preheating the air upstream of the main heater.

37. Apparatus according to claim 36 wherein the auxiliary heater includes a heat exchanger for transferring heat from used air exiting the container to cool air flowing to the main heater and comprises first and second air flow conduits separated by a common wall.

38. Apparatus according to claim 36 including an air blower in the air circulation system for generating the air flow therein, and wherein the blower comprises a portion of the auxiliary preheater and heats air by increasing a pressure thereof.

39. Apparatus according to claim 36 including a cooling tray positioned for receiving roasted beans from the container, and wherein the auxiliary preheater includes means for flowing cool air over the roasted beans on the cooling tray and thereafter into an intake of the air circulation system.

1 40. Apparatus according to claim 36 including means
2 operatively coupled with the air circulation system for
3 reducing a temperature of used air exiting the container to
4 about room temperature upstream of the air discharge.

1 41. Apparatus according to claim 40 wherein the air
2 temperature reducing means comprises a counterflow heat
3 exchanger for transferring heat from the used air exiting the
4 container to cool air in the circulation system before the
5 cool air reaches the main heater.

1 42. Apparatus according to claim 41 wherein the
2 used air exits the heat exchanger at a temperature
3 significantly above room temperature, and including a heat
4 sink between the heat exchanger and the air discharge for
5 lowering the temperature of the used air to about room
6 temperature.

1 43. Apparatus according to claim 35 wherein the air
2 cleaning arrangement comprises a main filter for removing
3 smoke from used air exiting the container.

1 44. Apparatus according to claim 43 wherein the
2 main filter comprises a mesh filter having a mesh size of .3
3 microns.

1 45. Apparatus according to claim 43 wherein the air
2 cleaning arrangement includes a HEPA filter downstream of the
3 main filter for removing white plume smoke from the used air.

1 46. Apparatus according to claim 45 wherein the
2 HEPA filter is a mesh filter having a mesh size of about 1
3 micron.

1 47. Apparatus according to claim 45 wherein the air
2 cleaning arrangement includes a screen collector for removing
3 bean chaff from the used air upstream of the main filter.

1 48. Apparatus according to claim 47 wherein the
2 chaff collector is a mesh filter having a mesh size of no more
3 than about 30 microns.

1 49. Apparatus according to claim 47 including a
2 heat exchanger located downstream of the main filter for
3 transferring heat from the used air to relatively cool air
4 flowing through the circulation system upstream of the heater.

1 50. Apparatus according to claim 49 including a
2 final filter located downstream of the heat exchanger and
3 upstream of the air discharge for removing volatile organic
4 compounds (VOCs) and hydrocarbons from the used air before it
5 reaches the air discharge.

1 51. Apparatus according to claim 50 wherein the
2 final filter comprises an activated carbon filter.

1 52. Apparatus according to claim 51 including an
2 air cooler in the air circulation system located downstream of
3 the heat exchanger and upstream of the HEPA filter and the
4 activated carbon filter for lowering a temperature of the used
5 air to no more than about 115°F.

1 53. A method for roasting coffee beans inside a
2 store comprising the steps of placing fresh beans inside a
3 container; electrically heating air to a desired roasting
4 temperature; flowing the heated air through the container and
5 about the fresh beans therein to thereby roast the beans;
6 filtering hot air exiting the container to remove therefrom
7 substantially all oily and white plume smoke, volatile organic
8 compounds, hydrocarbons, and other particulate subject matter
9 of a size larger than about 1 micron so that, thereafter, the
10 air is substantially pollutant-free; cooling used air exiting
11 the container to a temperature of no more than about 115°F;
12 and thereafter discharging the filtered and cooled air
13 directly into the store, whereby the discharged air will cause
14 substantially no pollution of air inside the store.

1 54. A method according to claim 53 including the
2 step of spectrally analyzing the beans with an instrument
3 generating an output signal which is a function of one of the
4 color and the darkness of the beans in the container; and
5 removing the beans from the container to thereby terminate
6 their roasting when the output signal indicates that the beans
7 have reached a predetermined color or darkness.

1 55. A method according to claim 53 wherein the step
2 of filtering comprises providing a plurality of flow-through
3 filters; flowing the used air successively through the filters
4 to remove substantially all pollutants therefrom, monitoring
5 air pressure drops across each filter, removing and cleaning
6 each filter when an associated corresponding air pressure drop
7 exceeds a predetermined value; and thereafter reinstalling the
8 cleaned filter.

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1 56. A method for uniformly roasting coffee beans at
2 a plurality of geographically separate locations comprising
3 the steps of placing a roasting machine at each location;
4 equipping each roasting machine with a roasting container for
5 holding fresh beans while they are being roasted, a hot air
6 supply for heating the fresh beans to a roasting temperature,
7 and an air removal system for directing used air away from the
8 container and removing therefrom substantially all debris,
9 smoke, oil, and the like so that air can be discharged into
10 the atmosphere after it has passed the beans in the container
11 without polluting it; observing the beans in the container
12 during roasting with a reflectometer and therewith generating
13 an output signal which reflects the observed darkness of the
14 beans; providing each roasting machine with a computer
15 including a memory; feeding the output signal to the computer;
16 at a central control station determining an optimal darkness
17 for each bean type that will be roasted by the roasting
18 machines; at the control station generating a control signal
19 which reflects the optimal darkness of each roasted bean type;
20 downloading the control signal from the central control
21 station to the computer of each roasting machine; during

22 roasting at any given roasting machine comparing the control
 23 signal stored in the associated memory with the output signal
 24 generated by the instrument; when the compared signals match,
 25 generating a command signal; and using the command signal to
 26 terminate the roasting of the beans in the container.

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 57. The method according to claim 56 including the
 2 steps of keeping an inventory of fresh beans proximate each
 3 roasting machine; monitoring the size of the fresh bean
 4 inventory; generating a low-inventory signal when the fresh
 5 bean inventory drops below a predetermined level; transmitting
 6 the inventory control signal to the central control station;
 7 and transferring additional fresh beans to the roasting
 8 machine which generated the low-inventory signal upon receipt
 9 thereof at the control station.

58. A method according to claim 56 wherein each
 2 roasting machine has a plurality of different fresh bean types
 3 which can be roasted; and including the steps of generating an
 4 optimal darkness signal for each bean type at the control
 5 station; downloading each darkness signal to the computers of
 6 the roasting machines of the system; and, during roasting at
 7 any given one of the roasting machines, comparing the output
 8 signal from the instrument with the stored darkness signal
 9 which corresponds to the bean type being roasted in the
 10 container.

59. A method for treating matter that releases
 2 atmosphere polluting materials when subjected to heat, the
 3 method comprising the steps of providing a chamber including
 4 an inlet and an outlet, placing the material in the chamber,
 5 generating the air flow and directing it along an upstream
 6 flow path through the inlet into the chamber, heating the air
 7 flow in the upstream flow path to form a hot air flow, and
 8 directing the hot air flow through the inlet into the chamber,
 9 whereby materials released by the matter become entrained in
 10 the hot air flow, thereby generating a polluted air flow;
 11 directing the polluted air flow through the outlet into a

12 downstream flow path; in the downstream flow path removing
13 most of the materials from the polluted air flow to thereby
14 generate a clean air flow which can be discharged into the
15 atmosphere without causing substantial air pollution; cooling
16 the air flow in the downstream flow path to a temperature
17 suitable for release of the air into a closed environment; and
18 limiting the flow time for the air flow from an upstream end
19 of the upstream path to a downstream of the downstream path to
20 substantially no more than about 1 second.

1 60. A method according to claim 59 wherein the step
2 of cooling comprises the step of transferring a major portion
3 of heat energy in the air flow through the downstream flow
4 path to the air flow in the upstream flow path.

1 61. A method according to claim 60 wherein the step
2 of limiting comprises the step of limiting the flow time to no
3 more than about 1/4 second.

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